Introduction

The ASI-CGS is participating in the Associate Analysis Center in the IGS LEO Pilot Project. Participating Centers of the Pilot Project provide POD solution for Low Earth Orbiters (LEOs) carrying spaceborne GPS receivers. The two first IGS LEO Campaigns have been devoted respectively to CHAMP (2002) and JASON-1 (2003) missions, and overall results and comparison methodology can be found in http://reg.esa.int/igslcsgpsslifehtml.

ASI has provided POD solutions for both the campaigns. Hereafter, technical details of the dynamic approach adopted, based on the use of the VMS/MicroCoM and NASA/GODDYN II software, are presented. The highly frequent estimation of empirical parameters to absorb unmodelled dynamic effects, makes the ASI adopted POD strategy an example of reduced dynamic approach.

IGS Orbit Campaigns

<table>
<thead>
<tr>
<th>Inclination</th>
<th>Perigee Height</th>
<th>Eccentricity</th>
<th>Campaign data span</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHAMP-1</td>
<td>87 deg</td>
<td>418 km</td>
<td>2001, 140-150 doy</td>
</tr>
<tr>
<td>JASON-1</td>
<td>66 deg</td>
<td>1336 km</td>
<td>2002, 154-182 doy</td>
</tr>
</tbody>
</table>

GPS Data processing for IGS Orbit Campaigns at CGS

The MicroCoM vs 2002.00 (by Van Marum System, Inc.) software was used for the entire CHAMP data processing. JASON-1 data have been preprocessed by MicroCoM to form the double differences, while the Orbit parameters were estimated by GEODYN II.

For each campaign, data batches (24 hours for CHAMP, 26 hours for JASON-1) have been analyzed separately; the estimation of clock drift was performed for each receiver using GPS navigation observables and pseudorange data. A preliminary estimation of the carrier phase ambiguities and cycle slip detection and fixing were contemporarily carried out. For each batch, keeping fixed the IGS final orbit, a ‘preliminary’ solution is produced, with troposphere parameters estimated every 2 hours for each station; then, a ‘preliminary Orbit solution’, from GPS navigation data is prepared; both the solutions are used to determine the ‘final LEO Orbit solution’, as depicted in the data processing flow (Fig 1).

A critical feature of the data processing for the ‘final LEO Orbit solution’ is the estimation strategy for the empirical accelerations. A very frequent estimation of empirical accelerations in along and cross direction has been included in order to compensate dynamic modeling deficiencies for the LEO satellite. This parameterization has permitted to make the estimated Orbit follow the data and to reduce the data residual RMS, but an effective assessment of ASI solution has not been obtained only after a wide comparison in the framework of IGS LEO Orbit Campaign by ESOC. In Tab. 1 and 2 the selected stations with ‘weak’ ITRF coordinates are listed.

CGS CHAMP and JASON-1 POD results

The internal consistency of the produced POD solutions can be provided by several indicators internal to the processing procedure, as the RMS of data residuals, or derived, as the difference of overlapping arc. Anyway, only an external validation/comparison allows a verification of the POD results, with a realistic estimation of the orbit precision.

The IGS LEO Comparison Campaign has allowed to ‘score’ the solutions submitted by the various analysis centers, evaluating their precision by crossing the pair-wise orbit error analysis and the tracking data analysis (SLR for CHAMP, SLR-TOPEX for JASON-1) results, as reported by http://reg.esa.int/prism/mobile.html.

The final CGS CHAMP solution, submitted at the beginning of 2003, has been evaluated at 13 cm precision level, while a preliminary CGS JASON-1 solution, submitted at the beginning of 2003, has been evaluated at 11 cm precision level.

Two updated JASON-1 POD solutions have been recently submitted, concerning respectively:
- the removal of some mismatches of the transformation from inertial J2000 to ITRF2000 reference system; this update has permitted to remove an anomalous Z rotation of about 2 masec with respect to the orbit of the other analysis centers;
- the use of GPS satellite general acceleration estimation parameters along GPS X-axis and GPS Y-axis together with the sine and cosine components (according to the IGS standard) instead of the only Y-bias constant.

Conclusively, a better precision level is expected for their evaluation within the IGS LEO Comparison Campaign.

An example of orbit comparison (CHAMP) between ASI and ESOC solutions is reported in Fig. 4.

Conclusions

ASI-CGS has been performing several POD analysis activities, within the frame of SLR and GPS geodetic techniques. In the context of the IGS LEO POD Pilot Project, GPS positioning of CHAMP and JASON-1 has been evaluated by MicroCoM and GEODYN II. Following a reduced dynamic approach, the POD assessment performed within the IGS LEO Comparison Campaign, has evaluated CGS CHAMP POD solution at 13 cm precision level, and a preliminary CGS JASON-1 POD solution at 11 cm precision level. Updated versions of the JASON-1 POD solution have been submitted recently; a better ‘score’ is expected.